Synthesis, Characterization and Photocatalytic Applications of Bi_2O_2S and its Composites: CO_2 Reduction and Dye Degradation

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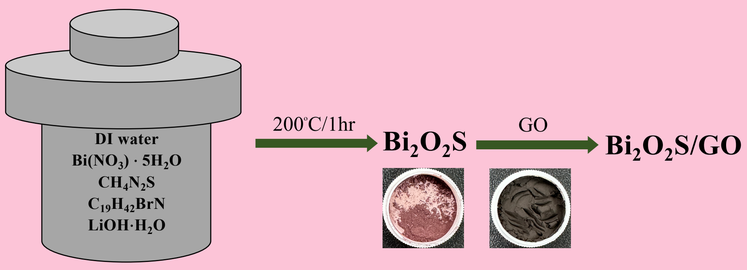
Abstract

We successfully synthesized Bi_2O_2S using a simple hydrothermal method. A series of Bi_2O_2S/g-C3N4 and Bi_2O_2S/GO photocatalysts were prepared by varying the weight ratios of g-C_3N_4 and GO. The resulting products were characterized using XRD, FE-TEM, FT-IR, SEM-EDS, DR-UV, BET, PL, EPR, and HR-XPS. To evaluate the photocatalytic efficiency of Bi_2O_2S、Bi_2O_2S/g-C_3N_4 and Bi_2O_2S/GO, these catalysts were tested for CO_2 conversion into hydrocarbons and for the photocatalytic degradation of crystal violet (CV). The Bi_2O_2S-9wt% GO composite exhibited the highest photocatalytic activity, with a rate constant of 0.027 h^{-1}, which is 3 times higher than that of Bi_2O_2S alone. This research demonstrates the potential for photocatalytic CO_2 reduction and organic pollutant degradation, contributing to advancements in green energy and environmental protection.

Results and Discussion

Catalysts Preparation



XRD

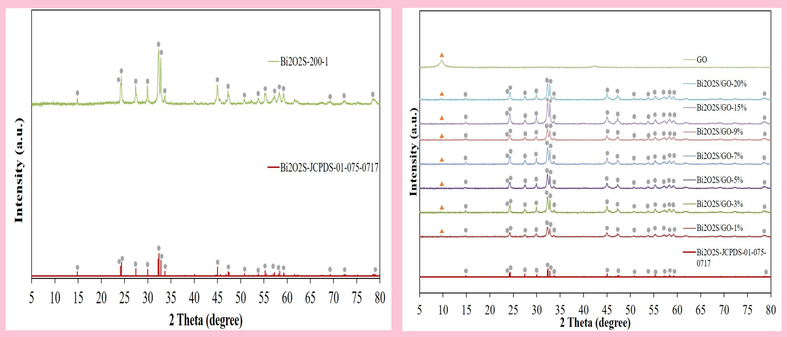
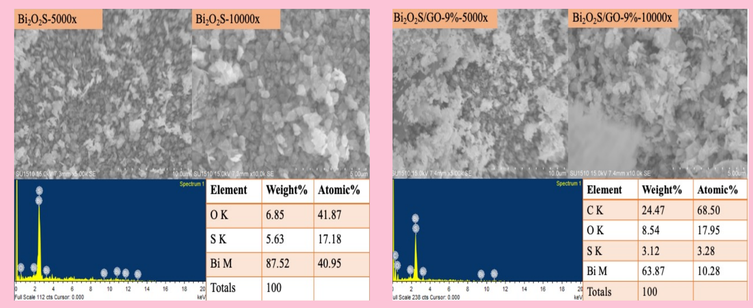


Fig.1 XRD patterns of $Bi_2O_2S$and Bi_2O_2S/GO.

FE-SEM-EDS



Element	Weight%	Atomic%
O K	6.85	41.87
S K	5.63	17.18
Bi M	87.52	40.95
Totals	100	

Element	Weight%	Atomic%
C K	24.47	68.50
O K	8.54	17.95
S K	3.12	3.28
Bi M	63.87	10.28
Totals	100	

Fig.2 FE-SEM images and EDS of Bi_2O_2S, Bi_2O_2S/GO-9%.

BET

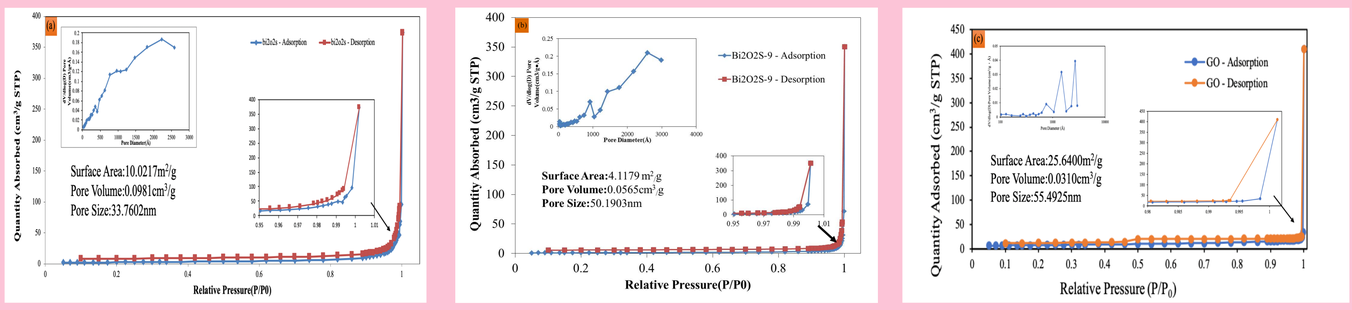


Fig.3 N_2 adsorption isotherm and pore size distribution of (a) Bi_2O_2S and (b) Bi_2O_2S/GO-9% (c) GO.

Photocatalytic Degradation of CV

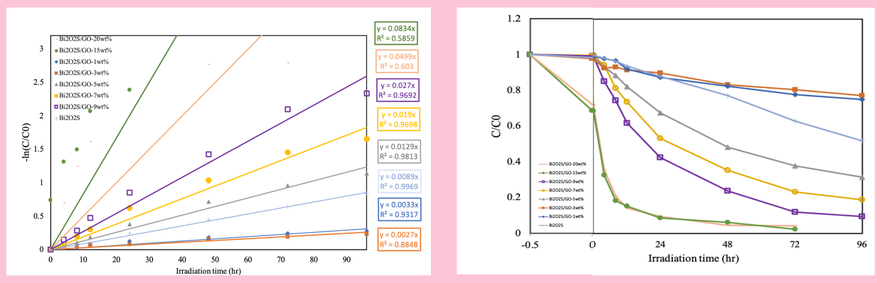


Fig.4 Photodegradation of CV as a function of irradiation time over different Bi_2O_2S/GO photocatalysts.

UV-Vis-NIR

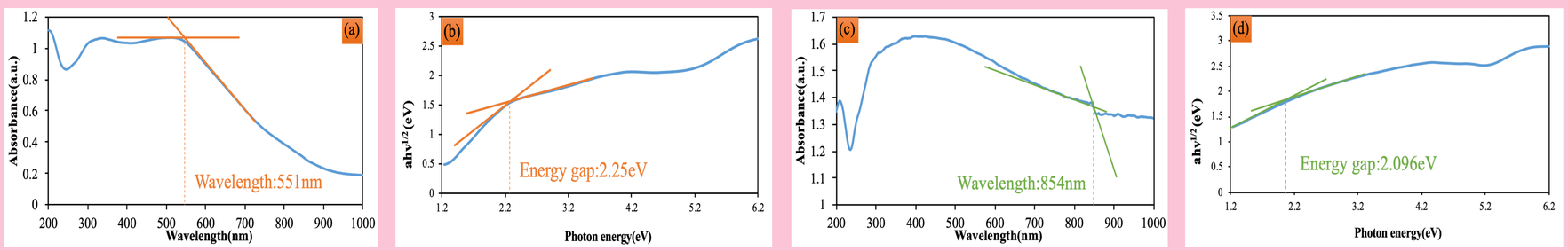


Fig.5 NIR pattern of Bi_2O_2S (a)wavelength (b)energy gap and GO (c)wavelength (d)energy gap.

PL

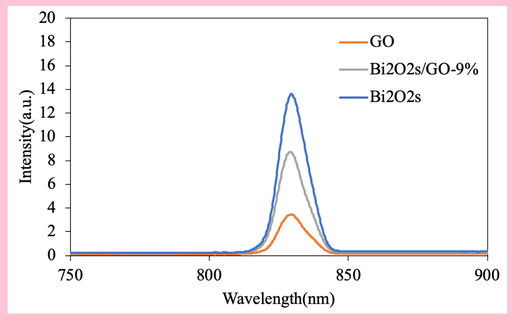


Fig.6 PL pattern of Bi_2O_2S, Bi_2O_2S/GO and GO .

EPR

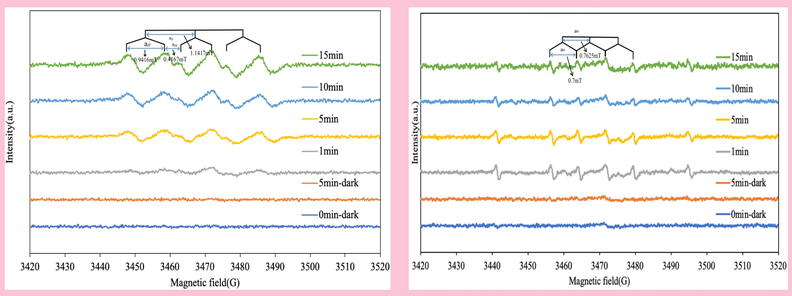


Fig.7 EPR pattern of Bi_2O_2S/GO-9% .

Mechanism

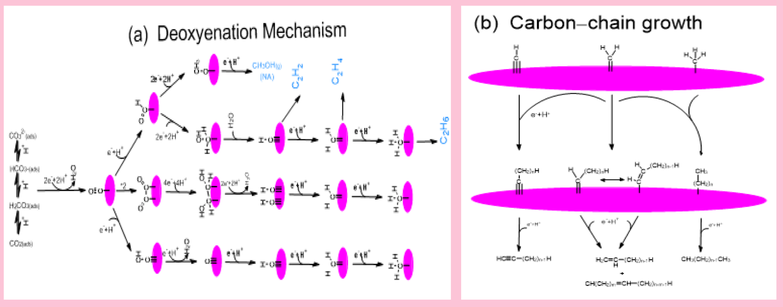


Figure.8 Proposed mechanisms of (a) deoxygenation and (b) C-C coupling on photoreduction CO_2 with Bi_2O_2S/GO photocatalysts.

Summary

This study successfully synthesized Bi_2O_2S and its composites, finding that Bi_2O_2S-9wt% GO exhibits the highest photocatalytic activity, with degradation efficiency three times that of pure Bi_2O_2S. This result demonstrates its potential applications in green energy and environmental protection.